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(71) Applicant
Maverex International Limited

(Incorporated in the United Kingdom)

Unit 9, Old Forge Trading Estate, Dudley Road, Lye, Stourbridge, West Midlands, DY9 8EL, United Kingdom

(72) Inventor
Reginald Lawrence Langham

(74) Agent and/or Address for Service
Forrester Ketley & Co
Chamberlain House, Paradise Place, Birmingham B3 3HP, United Kingdom

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UK CL (Edition K) B3F FDQ FDR FDT FPB FPG
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(54) Removing moulding material particles from a casting

(57) A casting made using a mould or core comprising particulate material is removed from and/or cleared of particulate by subjecting the casting and mould or core to an elevated temperature below the melting point of the casting, but high enough to promote chemical breakdown of the binder in the mould or core material. This obviates the use of mechanical effects such as vibrations which could damage a casting of a relatively low melting temperature metal like aluminium.

The treatment can be effected in a furnace having sand collection chutes (22, 24) for collecting sand falling away under the action of gravity or blown away by a hot gas stream induced to flow by a fan (20).

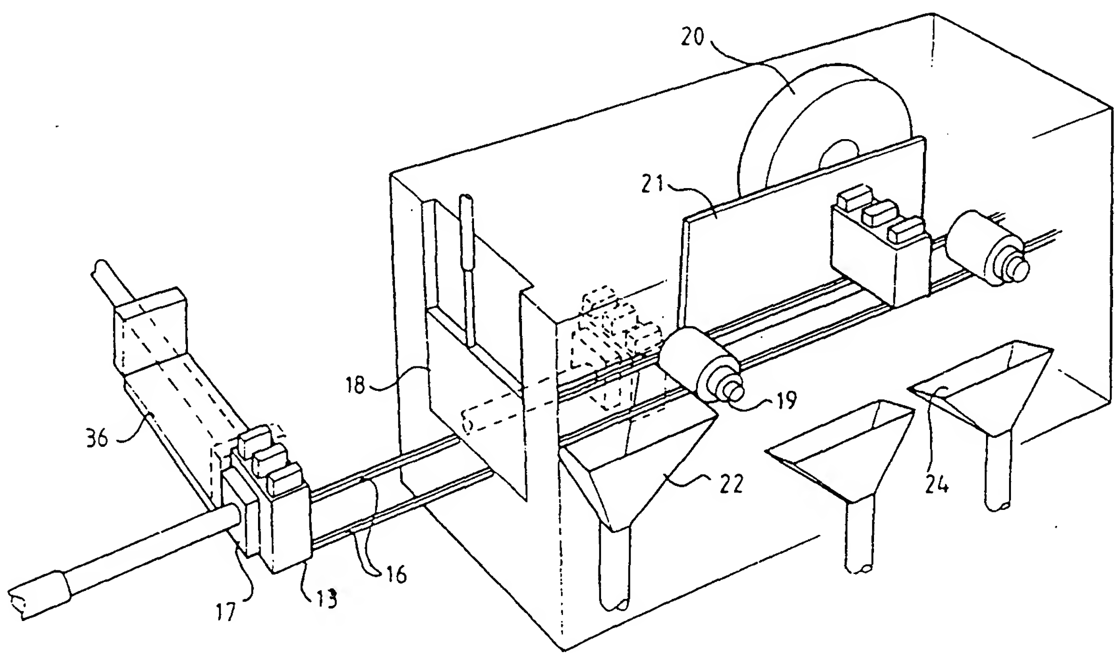

FIG 2

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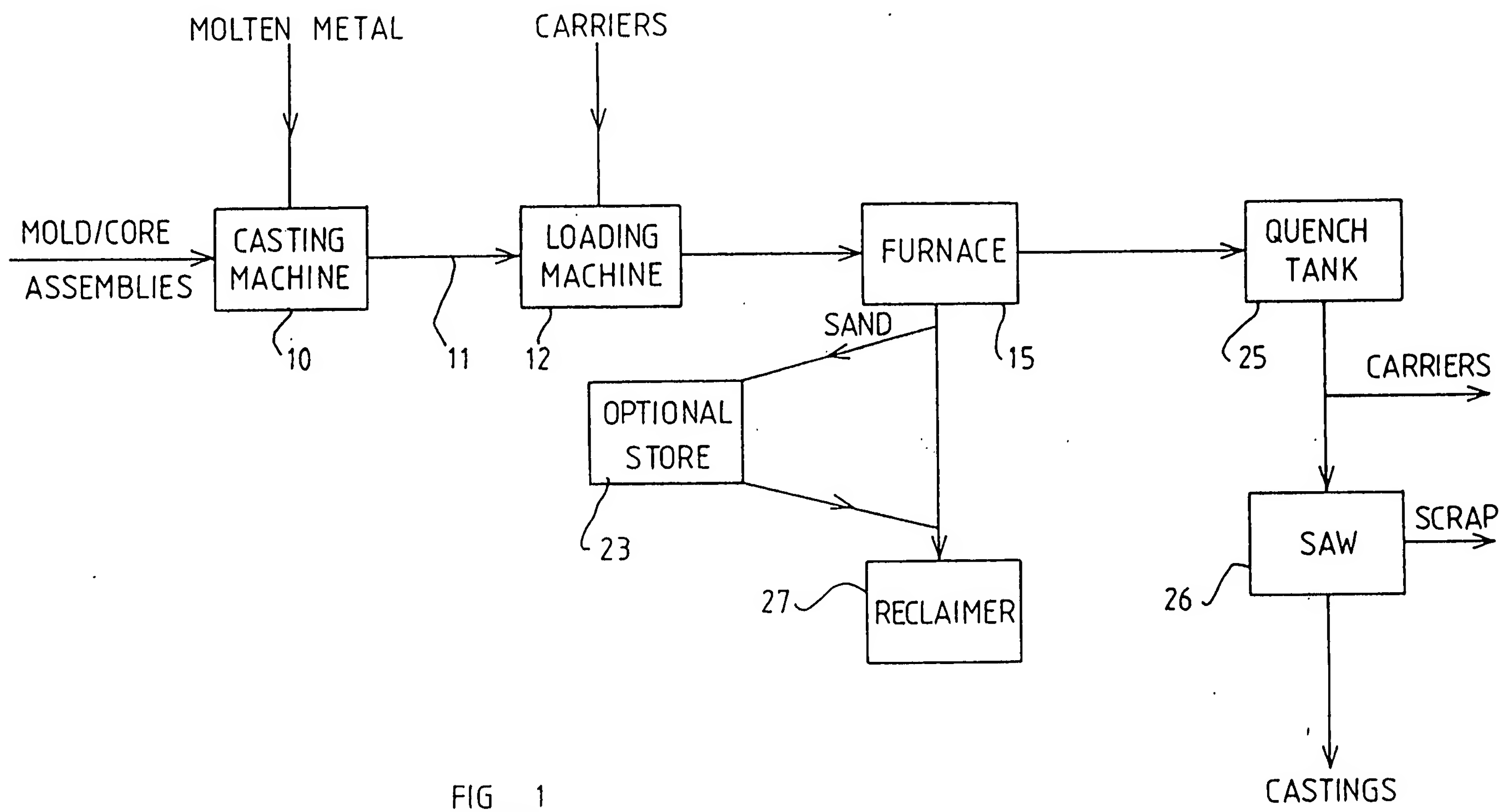
MOLTEN METAL
CARRIERS
MOLD/CORE ASSEMBLIES
CASTING MACHINE
10
11
LOADING MACHINE
12
FURNACE
15
SAND
OPTIONAL STORE
23
RECLAIMER
27
QUENCH TANK
25
CARRIERS
SAW
26
SCRAP
CASTINGS

FIG 1

necessary for the combination to be struck so violently that a ferrous casting would be damaged.

A casting of a low melting point metal is relatively vulnerable to mechanical damage. Accordingly, such a casting is cooled before the combination of the casting and the body in which the casting has been formed is subjected to mechanical shock to disrupt the body. It will be appreciated that the use of a vibrating table or other apparatus which subjects the combination to repeated impacts will inevitably subject the casting to direct impacts, as the body separates from the casting. Particularly when the casting is hot, subjection of the casting to direct impacts involves a substantial risk of the casting being impaired. The usual procedure is to cool the combination of casting and body, subject the combination to the action of a vibrating table until the body has been disrupted, remove the casting from the vibrating table, cut sprues from the casting whilst the casting is still cool and then subject the casting to heat treatment which involves heating the casting to a temperature in the region of 500°-550° C. It will be appreciated that cooling of the newly-formed casting and subsequent re-heating for the purpose of heat treatment is inefficient in the use of energy.

We have discovered that the use of mechanical action to disrupt the body of bonded particles from a casting of a low melting temperature metal can be avoided. This makes it possible to avoid cooling of the casting to ambient temperature prior to heat treatment and enables energy to be used more efficiently.

According to a first aspect of the present invention, there is provided a method of separating refractory particles from a casting of a low melting temperature metal, which casting has been formed in a cavity defined, at least in part, by a body comprising a mass of said particles bonded together by a binder, wherein the combination of the casting and said body is subjected to a temperature which is below the melting point of the casting but is sufficiently high to promote chemical breakdown of the binder for

a period such that the body collapses and wherein the particles resulting from collapsing of the body are removed from the casting by the action of gravity and/or a gaseous stream.

In a method in accordance with the invention, chemical breakdown of the binder rather than mechanical action is relied upon to bring about collapsing of the body. It will be appreciated that it is not necessary for the chemical breakdown to proceed to the point at which the body has disintegrated entirely into particles which are no longer bonded to one another. It is sufficient for the collapsing of the body to proceed sufficiently for the particles comprised by the body to be separated from the casting by the action of gravity and/or the action of the gaseous stream. Furthermore, it is not essential for all particles comprised by the body to be separated from the casting by the action of gravity and/or a gaseous stream. A minor proportion of the particles comprised by the body may remain with the casting during heat treatment thereof, for example until the casting is subjected to a quenching medium.

Typically, the heat treatment of an aluminium alloy casting has a duration of several hours. The whole of this period may be available for chemical breakdown of the binder. However, the chemical breakdown of the binder will usually proceed within a period of one or two hours to the point where the body has lost its integrity and almost all of the particles have separated from the casting.

Separation from the casting of a major proportion of the particles comprised by the body will not generally occur until the combination of body and casting has been subjected to said temperature for a period of several minutes, which period is relatively long, as compared with the period for which such combinations are subjected to the action of a vibrating table in the known procedure.

In the preferred method, the combination of body and casting is substantially at rest whilst the combination is subjected to said

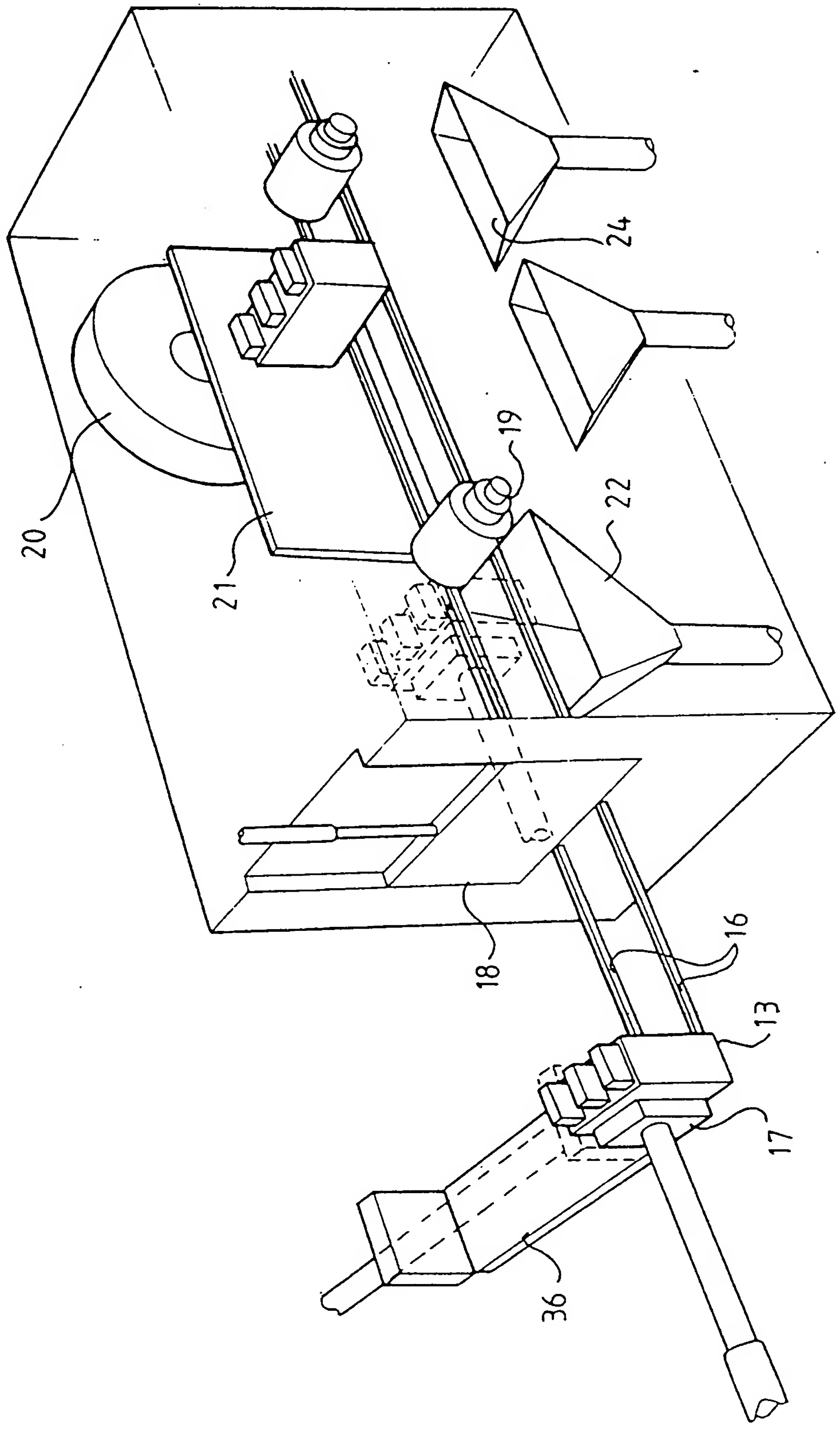

FIG 2

PATENTS ACT 1977

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Title:- "Method of and apparatus for separating refractory particles from a casting"

Description of the Invention

The present invention relates to the separation of refractory particles from a casting of a low melting temperature metal, which casting has been formed in a cavity defined, at least in part, by a body comprising a mass of said particles bonded together by a binder.

As used herein, the term "metal" embraces metallic elements and alloys. Aluminium and its alloys are typical examples of low melting temperature metals. The body may be a mold and/or a core. The mold may comprise a plurality of separately formed parts. There may be a plurality of cores. Typically, the body comprises a multi-part mold and a plurality of cores.

After a casting has solidified in a body of the kind described, the body is disrupted by mechanical action, in order to separate the body from the casting. Typically, the combination of body and casting is permitted to cool and is then struck repeatedly or vibrated to disrupt the body. In some cases, subjecting the combination to repeated mechanical shocks is insufficient to disrupt and dislodge the body entirely and the combination is subjected to the mechanical action of a jet of liquid in which solid particles are entrained or is blasted by a stream of sand particles or metal shot. Mechanical distuption of the body is typically completed within a few seconds. In a case where the body is in combination with a ferrous casting, disruption of the body by subjecting the combination to repeated mechanical shocks over a period of a few seconds is usually satisfactory. Although the shocks must be vigorous, in order to cause distuption of the body, it is not

temperature and the body is collapsing. By describing the combination as being substantially at rest, we mean that there is no deliberate, continuous moving of the combination such as occurs in the use of vibrating table. There may be intermittent movement. For example, there may be movement of the combination into a heating chamber and subsequent, intermittent movement of the combination along a feed path through the chamber. Furthermore, collapsing of the body will inevitably result in movement of the body and of the particles relative to the casting and may permit movement of the casting under the action of gravity. Typically, a gradual crumbling of the body will occur and this will permit gradual or intermittent movement of the casting under the action of gravity. However, it is unnecessary in a method in accordance with the present invention to shake or vibrate the body continually or continuously, in order to promote collapsing of the body. Movement of the casting is a consequence of collapsing of the body, rather than the cause of collapsing of the body.

The combination may be supported on a stationary support whilst the combination is subjected to said temperature and the body is collapsing.

Also in the preferred method, the combination of body and the casting is placed in a carrier after solidification of the casting and before collapsing of the body is completed. In a case where a carrier is used in this way, the particles comprised by the body preferably escape from the carrier as the body collapses, leaving the casting in or on the carrier. It will be appreciated that there may be some loss of particles from the body prior to loading of the combination into a carrier and during loading. However, in a case where a carrier is used in a method according to the present invention, it is generally intended that at least a major part of the body will remain with the casting until the combination has been loaded into the carrier.

In a method in accordance with the present invention, the combination of body and casting is preferably maintained at a

temperature considerably above the ambient temperature from solidification of the casting until the body has collapsed. It will be appreciated that there will inevitably be some cooling of the casting after solidification and before the body has collapsed completely, because the body will normally be at a temperature much lower than the temperature of the molten metal which is poured into the body to form the casting. Solidification of the casting takes place by transfer of heat from the metal to the body and such transfer will continue after solidification. Furthermore, as the temperature of the body is raised by the transfer of heat from the metal, the body itself will begin to loose heat to its surroundings. However, in a method in accordance with the present invention, the loss of heat from the combination is preferably restricted to a degree which is compatible with the required solidification of the metal so that the loss of heat from the combination is not excessive and the thermal energy required to be imparted to the body to raise the temperature of the body to a level at which the required chemical breakdown of the binder occurs is minimised.

According to a second aspect of the invention, there is provided apparatus for use in a method according to the first aspect and comprising a furnace having a heating chamber, a normally stationary support for workpieces in the heating chamber, a receiver for receiving particles from a workpiece on the support and heating means for imparting heat to a workpiece on the support.

By describing the support as normally stationary, we mean that the support is stationary for a major part of a period during which the apparatus is in use. The support may be moved intermittently for the purpose of advancing castings along a feedpath. Alternatively, the castings may be moved along a feedpath relative to the support.

The apparatus may further comprise a carrier for the combination of body and casting, the carrier being interposed, in use, between the support and the combination. The carrier may

slide on the support when the carrier and combination are advanced along a feedpath through the furnace.

An example of apparatus embodying the second aspect of the invention and which is used in a method according to the first aspect will now be described, with reference to the accompanying drawings, wherein:-

FIGURE 1 is a diagram illustrating the flow of materials between several units of the apparatus; and

FIGURE 2 shows diagrammatically a furnace incorporated in the apparatus.

The apparatus illustrated in the accompanying drawings includes a casting machine 10 to which there is supplied a molten aluminium alloy and pre-formed molds. Each mold is typically an assembly of two or more parts, each of which comprises a mass of particles bound into a coherent body by a foundry binder. The particles are typically of sand, for example zircon sand or silica sand. The binder may be any known foundry binder which will undergo thermal breakdown at a temperature below the melting point of the metal which is cast. Each mold incorporates one or more cores, these also comprising refractory particles bound into a coherent body by a foundry binder which will suffer breakdown at a temperature below the melting point of the metal. The binders used in the core and in the mold may be the same or may be different.

The casting machine 10 may be a known casting machine. The machine may introduce the molten metal into each mold by pouring the molten metal into a gate system under the action of gravity or by the application of pressure to drive the metal into a gate system and the mold cavity.

Each mold which has been charged with molten metal is conveyed from the casting machine 10 by a conveyor 11. The molten metal looses heat to the mold and to the cores so that the metal

cools sufficiently to solidify. The mold is correspondingly heated and may attain a temperature in the region of 300^{o}-350^{o} C. The conveyor 11 delivers the charged molds to loading apparatus 12. The loading apparatus also receives carriers for the charged molds. Typically, each carrier is adapted to receive a plurality of molds. By way of example, we have illustrated carriers 13, each of which is adapted to receive three molds, each containing a respective casting. Prior to loading a mold into the carrier 13, any fibrous seal present on the mold is removed and the mold is removed from a platen 14. The loading apparatus may be known handling apparatus, for example as used for loading castings or other workpieces into carriers.

The apparatus further comprises a furnace 15. In the heating chamber of the furnace, there is provided a support for a row of carriers 13. The particular example of support illustrated in Figure 2 of the drawings comprises a pair of rectilinear, mutually parallel rails 16. The rails 16 define a feedpath along which carriers can be advanced through the furnace. For moving the carriers along the rails 16, there is provided a pusher 17 which is mounted outside the furnace, adjacent to one end thereof. When a door 18 of the furnace is open, the pusher can advance to a position just inside the furnace and thereby push a carrier from a position outside the furnace to a position inside the furnace, also pushing the carriers in the row within the furnace along the rails towards an opposite end of the furnace.

The rails 16 may extend completely through the furnace and the pusher 17 may be used to push the carriers through the furnace from one end thereof to the other. Alternatively, a further feed means may be provided for feeding carriers along a part of the feedpath through the furnace. Conveyors suitable for use in heat treatment furnaces are well known.

The furnace 15 is provided with heating means for heating the contents of carriers which are introduced into the furnace. The heating means illustrated, by way of example, comprises one or

more burners 19 for mixing a gaseous fuel with combustion air and discharging a burning mixture of the fuel and air into the heating chamber of the furnace. One or more fans 20 are provided for circulating the atmosphere inside the furnace to promote transfer of heat from the products of combustion to the contents of the carriers 13. Baffles, one of which is illustrated at 21, may be provided in the furnace to define the path along which the atmosphere of the furnace is circulated.

The general construction and arrangement of the walls, burners, fans and baffles of the furnace may be as in known heat treatment furnaces. It will be understood that the furnace would, in practice, be of considerable length and may provide a residence time for each carrier within the furnace which is in excess of five hours. Accordingly, the number of fans and burners may be considerably greater than in the example illustrated.

At the bottom of an upstream portion of the furnace 15, there is provided a receiver 22 for receiving particles which fall from the carriers resting on the support rails 16. The receiver 22 preferably extends across the entire width of the furnace and along a substantial part of the length of the furnace. In practice, there may be a row of receivers extending along a part of a length of the furnace. The receiver 22 is downwardly convergent and leads to a chute along which particles can slide into a hopper 23 for temporary storage.

That part of the bottom of the furnace 15 which is downstream of the receiver 22 or receivers is substantially flat. At one side of the furnace, there is in the substantially flat bottom a row of openings 24 through which particles can pass to additional chutes which deliver the particles to the hopper 23. The fans and baffles are so arranged that a rapid stream of gases traverses the bottom of the furnace towards the openings 24 to blow to the openings any particles which fall onto the substantially flat bottom of the furnace.

Adjacent to the downstream end of the surface 15, there is

provide a quench tank 25 containing a quenching medium into which each carrier which emerges from the furnace is lowered. There may also be provided a rinse tank in which each carrier and its contents are rinsed, after being withdrawn from the quench tank. Quenching and rinsing reduces the temperature of each carrier and its contents to a value near to ambient temperature. The castings are then removed from the carrier and mounted in a jig in a saw 26 which cuts sprues from the casting.

It will be noted that there is no deliberate cooling of the molds before they are introduced into the furnace 15. There will be some loss of heat from each mold during conveying of the mold to the loading apparatus 12 and loading of the mold into a carrier 13. However, the molds will be at a temperature considerably above the ambient temperature, for example a temperature in the range of 300° to 350°C, when they enter the furnace 15. When the molten metal is poured into each mold, that part of the mold which is immediately adjacent to the interface between the metal and the mold will be heated to a temperature considerably above 300°C. This may cause local breakdown of the binder in that part of the mold which is close to the casting. However, the binder in the major part of the mold will retain until the mold is in the furnace 15 its ability to bind the particles of the mold into a coherent body. Transfer of the mold from the conveyor 11 to a carrier 13 may result in loss of some particles from the mold but the major part of the mold will remain with the casting, when the latter is transferred to the furnace.

In the furnace, the temperature of each carrier and of the molds and castings carried therein will be raised to a temperature in excess of 300°C, but below the melting point of the metal. Typically, the temperature of each mold and casting will be raised to a value within the range 520° to 530°C. The castings may be maintained at this temperature until they leave the furnace.

Heating of the molds to a temperature in excess of 500°C causes the chemical breakdown of the binder. Accordingly, the

mold gradually disintegrates into particles or conglomerations of particles and the mold collapses. Furthermore, each core contained in the casting also disintegrates and collapses. The resulting particles or agglomerations of particles fall from the casting.

The carriers 13 are adapted to permit the furnace atmosphere to flow through the carriers into contact with the molds and castings and to permit particles and agglomerations of particles to fall from the carriers. Accordingly, each carrier has the form of an open framework or of a basket. It will be noted that each carrier rests only on the rails 16 and that the rails do not signifincantly impede flow of atmosphere through the carrier and do not impede escape of particles and agglomerations of particles from the carrier.

The flow of the furnace atmosphere over and through each casting is at a sufficiently high velocity to blow particles from the casting. Accordingly, the particles resulting from disintegration of the mold and or the cores are removed from the casting partly by the action of gravity and partly by the action of the stream of gases circulating in the furnace chamber. Most of the particles will fall into the receiver 22 (or into one of the receivers, in a case where more than one receiver is provided). The residence time of each carrier above the receiver or receivers, considered collectively, is such that collapsing of each core will have been completed whilst the corresponding carrier is above the receiver or one of the receivers. Accordingly, only minor amounts of mold or core material, if any, will be carried by the castings over the substantially flat floor portions of the furnace. Here also, the stream of gases circulating within the furnace chamber flows over and through the castings with a velocity such that remaining particles are blown from the casting towards the opening 24. Any particles which remain on or in a casting when the latter emerges from the furnace will be washed from the casting by the quenching medium and/or by the rinsing medium.

The binders used to form the molds and the cores are typically organic compositions which, upon thermal de-composition,

release fumes into the furnace atmosphere. Accordingly, it is necessary to treat the atmosphere which is discharged from the furnace. Such treatment involves combustion of the fumes resulting from thermal decomposition of the binder. Combustion of the fumes may be effected in a known manner.

Binder residues which remain on the particles resulting from disintegration of the molds and cores are removed from the particles in a reclaimer 27. A known reclaimed may be used. The reclaimer may comprise, for example, a fluidised bed into which the particles are introduced and in which the particles are heated by combustion of a fuel or otherwise. Air may be introduced into the fluidised bed to support combustion of the binder residues. Preferably, atmosphere exhausted from the furnace 15 is directed into the reclaimer at a level above the fluidised bed so that the fumes are mixed with excess air rising from the bed and are heated to promote combustion of the fumes. Other known treatments for removing pollutants may be applied to the furnace gases, before these are discharged to the atmosphere. Furthermore, the exhaust gases are cooled by the transfer of heat to air which is then used to support combustion in the fluidised bed and which may additionally be fed to the furnace 15, for example as combustion air supplied to the burners which heat the furnace.

The features disclosed in the foregoing description, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS:-

1. A method of separating refractory particles from a casting of a low melting temperature metal, which casting has been formed in a cavity defined, at least in part, by a body comprising a mass of said particles bonded together by a binder, wherein the combination of the casting and said body is subjected to a temperature which is below the melting point of the casting, but is sufficiently high to promote chemical breakdown of the binder, the combination is subjected to said temperature for a period such that the body collapses and wherein the particles resulting from collapsing of the body are removed from the casting by the action of gravity and/or of a gaseous stream.

2. A method according to Claim 1 wherein said combination of the body and the casting is placed in a carrier after solidification of the casting and before collapsing of the body is completed.

3. A method according to Claim 1 or Claim 2 wherein said combination of the body and the casting is maintained at a temperature considerably above ambient temperature from solidification of the casting until the body has collapsed.

4. A method according to any preceding Claim wherein, whilst said combination is subjected to said temperature and the body is collapsing, the combination is substantially at rest.

5. A method according to Claim 2 wherein the carrier and the casting are introduced together into a quenching medium.

6. A method according to any preceding Claim wherein said combination of the body and the casting is subjected to said

temperature for a period of at least several minutes before the body collapses.

7. Apparatus for use in a method according to Claim 1 and comprising a furnace having a heating chamber, a normally stationary support for workpieces in the heating chamber, a receiver for receiving particles from a workpiece on the support and heating means for imparting heat to a workpiece on the support.

8. Apparatus according to Claim 7 further comprising a carrier for said combination of the body and the casting, the carrier being interposed, in use, between the support and the combination.

9. Apparatus according to Claim 8 wherein the carrier is movable relative to the support along a feed path defined by the support.

10. A method substantially as herein described for separating refractory particles from a casting of a low melting temperature metal.

11. Apparatus substantially as herein described with reference to the accompanying drawing.

12. Any novel feature or novel combination of features disclosed herein or in the accompanying drawings.

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